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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/043,180	01/14/2002	Naoyuki Kofuji	XA-9608	6239

7590 06/23/2003

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EXAMINER
MACKEY, TERRENCE M

ART UNIT	PAPER NUMBER
1765	4

DATE MAILED: 06/23/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/043,180	KOFUJI ET AL.	
	Examiner	Art Unit	
	Terrence Mackey	1765	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____ .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1 - 15 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 1 - 15 is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other:

Detailed Action

Claim Rejections - 35 USC § 112

The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 1, 12, 13, and 15 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite as it is unclear what is meant by the phrase "including an aluminum".

Claim 9 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite as it is unclear which TiN layer is to be plasma etched with a mixture gas having CH_2CL_2 gas added in an amount of 0 to 4%.

Claim 12 is additionally rejected under 35 U.S.C. 112, second paragraph, as being indefinite as it is unclear what plural metal films are to be etched.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use of on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 1, 5 and 11 are rejected under 35 U.S.C. 102(b) as being anticipated by Watanabe et al. (6,156,663).

Applicant claims a method of manufacturing a semiconductor device comprising depositing a metal film including aluminum over a semiconductor substrate, and etching the metal film with a plasma of a mixture gas containing a Cl_2 gas, a BCl_3 gas, and a CH_2Cl_2 gas. The metal film may is further claimed to be a part of a multi-layer interconnection. A pattern to be etched in the metal film is further claimed to have a wiring pitch of less than 500 nm.

Watanabe et al. disclose an etching method for patterning a multi-layered of single-layered aluminum wiring using a mixture gas of Cl_2, BCl_3, and CH_4. Watanabe et al. disclose on column 8, lines 59-63, that similar effects can be expected by using a mixed gas having $C_xH_yCl_z$ (wherein each of x, y, and z is 0 to 8) and Ar in place of the CH_4 component. The etching process of Watanabe et al. is further disclosed to be effective in the formation of a wiring structure having dimensions of 0.5 um or less (column 7, lines 66-67).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 2 – 3, 6 – 7, 9, and 12 – 14 are rejected under 35 USC 103 (a) as being unpatentable over Watanabe et al. (6,156,663) in view of Abraham (4,838,992).

Applicant claims a method of manufacturing a semiconductor device comprising depositing a metal film including aluminum over a semiconductor substrate, and etching the

metal film with a plasma of a mixture gas containing a Cl_2 gas, a BCl_3 gas, and a CH_2Cl_2 gas, and wherein the pressure of the mixture gas is between 0.6 and 1.5 Pa and also wherein the CH_2Cl_2 has a purity of 99.99% or greater. Applicant also claims a method of manufacturing a semiconductor device comprising depositing a metal film including aluminum over a semiconductor substrate, forming patterns at a first wiring pitch and patterns at a second wiring pitch greater than the first wiring pitch, and etching the metal film with a plasma of a mixture gas containing Cl_2 gas, BCl_3 gas, and a CH_2Cl_2 gas. Applicant also claims a method for manufacturing a semiconductor device comprising forming a metal film including a stacked multi-layer film having a TiN layer, an aluminum layer, and a TiN layer, and etching the metal films with a plasma of a mixture gas containing a Cl_2 gas, a BCl_3 gas, and an additive gas obtained by diluting a CH_2Cl_2 gas with a dilution gas wherein the mole concentration of the CH_2Cl_2 gas after dilution with the dilution gas is 10% to 100%. Applicant also claims a method of manufacturing a semiconductor device comprising forming metal films by stacking a TiN film, an Al film, and a TiN film successively over a semiconductor substrate, and etching the metal film with a plasma of a mixture gas containing Cl_2 gas, BCl_3 gas, and a CH_2Cl_2 additive gas, wherein the CH_2Cl_2 gas is added in an amount of 0 to 4% upon etching of the TiN film whereas the amount of the CH_2Cl_2 gas is increase to 5 to 30% during etching of the Al film.

Watanabe et al. disclose a method for plasma etching an aluminum layer on a semiconductor wafer using a mixture gas of Cl_2 gas, BCl_3 gas, and CH_4 gas. The aluminum layer may be part of a multi-layered structure comprising a TiN cap layer, an aluminum alloy layer, and a TiN barrier layer. Watanabe et al. disclose on column 8, lines 59-63, that similar effects can be expected by replacing the CH_4 component with a mixed gas having $C_xH_yCl_z$

(wherein each of x, y, and z is 09 to 8) and Ar. Watanabe et al. do not teach the use of a gas pressure of between 0.6 and 1.5 Pa, nor the use of CH_2Cl_2 gas having a purity of 99.99% or greater or a mole concentration of the CH_2Cl_2 gas after dilution with a dilution gas of between 10% and 100%, nor the formation of wiring patterns having a first and second wiring pitch, nor varying the concentrations of the components of the mixture gas during the plasma etching process as claimed by applicant.

Abraham teaches the use of a gaseous mixture of Cl_2, BCl_3, and a hydrocarbon for plasma etching of aluminum films. Abraham discloses on column 3, lines 36-42, the use of gas pressures of between 5 and 20 mtorr that read on applicant's claimed pressure range. Abraham also discloses on column 5, lines 15-18, the use of an additional etching step using a lower Cl_2 flow rate with the remaining parameters unchanged. This change to the plasma etch conditions would thus effectively increase the amount of CH_2Cl_2 in the mixture gas of the additional etching step taught by Abraham.

It is the position of the Examiner that the dilution of the CH_2Cl_2 gas with a dilution gas wherein the mole concentration of the CH_2Cl_2 gas after dilution is 10% to 100% is inherent in the teaching of Watanabe et al. as one of ordinary skill in the art would be motivated to use different ratios of CH_2Cl_2 and Ar to be used as the mixed gas to be added to the Cl_2 and BCl_3 components of the plasma etching gas in order to achieve an expected result. It is also the position of the Examiner that the use of CH_2Cl_2 pas having a purity of 99.99% or greater is inherent in the teachings of Watanabe et al. and Abraham since one of ordinary skill in the art of semiconductor manufacture would be motivated to use gases of high purity to minimize the contamination of the semiconductor substrate. It is furthermore the position of the Examiner

that the formation of wiring patterns having a first wiring pitch and a second wiring pitch is inherent in the teachings of Watanabe et al. and Abraham since one of ordinary skill in the art would be motivated to form wiring patterns having different wiring pitches to form the various components of typical interconnections of a semiconductor devices to obtain an expected result.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the semiconductor manufacturing process of Watanabe et al. by using gas pressures taught by Abraham as well as to vary the composition of the mixture gas as taught by Abraham to provide for sidewall topographies with desirable characteristics.

Claims 4 and 8 are rejected under 35 USC 103 (a) as being unpatentable over Watanabe et al. (6,156,663) in view of Collins et al. (5,300,460).

Claims 4 and 8 include the additional limitation for manufacturing a semiconductor device comprising depositing a metal film including aluminum and etching the film with a plasma using a gas mixture containing a Cl_2 gas, a BCl_3 gas and a CH_2Cl_2 gas, wherein the plasma is generated using an electromagnetic wave within the frequency range of 300 MHz to 1 GHz.

Watanabe et al. teach the above described semiconductor device manufacture process having a step of plasma etching an aluminum layer using a gas mixture of Cl_2 gas, BCl_3 gas, and hydrocarbon gas. The reference does not teach the use of a plasma generated using an electromagnetic wave within the frequency range of 300 MHz to 1 GHz.

Collins et al. teach on column 3, lines 58-63, the use of plasmas generated by a VHF/UHF power source having a frequency of from about 150 MHz to about 600 MHz to etch an aluminum layer on a semiconductor wafer.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the semiconductor manufacture process of Watanabe et al. to use a plasma generated using the frequencies as taught by Collins et al. so that the sheath voltages will be low enough to avoid the risk of damage to devices on the wafer yet high enough to achieve desired etch anisotropy with desirable etch rates.

Claim 10 is rejected under 35 USC 103 (a) as being unpatentable over Watanabe et al. (6,156,663) in view of Davis et al. (4,828,649).

Applicant claims a method for manufacturing a semiconductor device comprising depositing a metal film including aluminum over a semiconductor substrate, forming a resist mask over the metal film, etching the metal film with a plasma of a mixture gas of Cl_2 gas, BCl_3 gas, and CH_2Cl_2 gas, and removing the resist mask with a plasma of a mixture gas containing an F element and an O element.

Watanabe et al teach the above described semiconductor device manufacture process having a step of plasma etching an aluminum layer using a gas mixture of Cl_2 gas, BCl_3 gas, and hydrocarbon gas. The reference does not teach the removal of a resist mask with a plasma formed from a mixture gas containing an F element and an O element.

Davis et al. teaches on column 63, lines 38-44, the plasma ashing of a resist on a semiconductor substrate using a mixture gas of oxygen and an ashing enhancement gas such as CF_4 or CHF_3 to achieve improved ashing rates.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the semiconductor manufacture process of Watanabe et al. by removing the

resist mask with a plasma of a mixture gas containing an F element and an O element as taught by Davis et al. to achieve improved ashing rates.

Conclusion

Remaining references cited to show the state of the prior art.

No claim is allowed.

Papers relating to this application may be submitted to Technology Sector 1700 by facsimile transmission. Papers should be faxed to Crystal Plaza 3, Art Unit 1765, using fax number (703) 305-6357. All Technology Section 1700 fax machines are available to receive transmissions 24 hrs/day, 7 days/wk. Please note that the faxing of such papers must conform to the Notice published in the Official Gazette, 1096 OG 30, (November 15, 1989).

Any inquiry concerning this communication or earlier communications from the Examiner should be directed to Terrence Mackey whose telephone number is (703) 305-5504. The Examiner can normally be reached Monday - Friday from 7:00 AM – 4:30 PM.

If attempts to reach the Examiner by telephone are unsuccessful, the examiner's supervisor, Ben Uteck, can be reached at (703) 308-3836.

Any inquiry of a general nature or relating to the status of this application should be directed to the receptionist whose telephone number is (703) 308-0661.

ROBERT KUNEMUND
PRIMARY EXAMINER

TMM

June 12, 2003